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Evidence for Odderon exchange from scaling properties of elastic collisions at the TeV scale

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We study the scaling properties of the differential cross section of elastic proton–proton (pp) and proton–antiproton ($p\bar{p}$) collisions at high energies. We introduce a new scaling function, that scales – within the experimental errors – all the ISR data on elastic pp scattering from $\sqrt{s} = 23.5$ to 62.5 GeV to the same universal curve. We explore the scaling properties of the differential cross-sections of the elastic pp and $p\bar{p}$ collisions in a limited TeV energy range. Rescaling the TOTEM pp data from $\sqrt{s} = 7$ to 2.76 and 1.96 TeV, and comparing it to D0 $p\bar{p}$ data at 1.96 TeV, our results provide an evidence for a t-channel Odderon exchange at TeV energies, with a significance of at least 6.26σ . We complete this work with a model-dependent evaluation of the domain of validity of the new scaling and its violations. We find that the $H(x)$ scaling is valid, model dependently, within $200 \leq \sqrt{s} \leq 8$ TeV, with a $-t$ range gradually narrowing with decreasing colliding energies.

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